NEWS

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# WHAT LIES AHEAD IN SPACE

Talk to the Economic Club of Detroit
By
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(NOTE: The following was the last public speech of Dr. Thomas O. Paine as NASA Administrator. You may find the information contained useful as reference material.)

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## I. POST APOLLO "PROCESS"

On July 20, 1969, the spacecraft Eagle touched down at Tranquillity Base and Neil Armstrong's first footsteps on the moon were flashed by communications satellites to history's largest audience on every continent. Men everywhere hailed this giant leap for mankind, but at NASA Headquarters, we realized that this triumph of Apollo also marked the beginning of its end. For eight years this challenging program had provided a central focus for America's space efforts. Its passing last year presented NASA management with a major new challenge comparable to President John F. Kennedy's 1961 decision that sent Americans to the moon.

The successful lunar landing meant that the Space Agency had to chart a new course in an entirely different political and social environment. President Nixon had to set new forward-looking space goals for the 1970's; the support of Congress and the American people had to be obtained; and new international arrangements had to be developed to increase participation by other nations in man's conquest of space. Turning around and redirecting a four-billion-dollar enterprise involving hundreds of thousands of people in government, industry and universities represents a major managerial challenge. Fortunately, an excellent start had been made.

In his first month in office, President Nixon had called together the Vice President, the Secretary of Defense, his Science Adviser, and me to meet as a task group. With the Vice President as chairman, our assignment was to develop for the new Administration a definitive recommendation on America's future in space. Two months after the Moon landing the completed Space Task Group Report was presented at a meeting with President Nixon. Entitled "The Post-Apollo Space Program: Directions for the Future," it provided him with the basis for his definitive statement of March 1970 setting forth the elements of a balanced new space program as a continuing part of American life. The report also furnished the basis for the new NASA budget submitted to Congress in January 1970 and for extensive discussions with other nations aimed at increasing international participation in future space developments.

The President reviewed and approved NASA's plans for increasing post-Apollo international cooperation in an informal meeting with Secretary of State Rogers, Dr. Henry Kissinger and me aboard Air Force One as we flew out to the Pacific splashdown of Apollo 11. Following this, I invited Soviet space leaders to consider new cooperative efforts in light of the Space Task Group plans, and just this weekend, met in Washington with the number two man in the Soviet Academy of Sciences, Dr. Millionshchikov, to explore further opportunities for U.S.-U.S.S.R. joint efforts in space. I have also asked other nations to participate in the new space program of the 1970's in a series of visits to London, Bonn, Paris, The Hague, Brussels, Ottawa, Canberra, Tokyo and Washington. These negotiations are continuing with the visit of a European delegation this week, and prospects for meaningful international space programs appear very promising.

The Senate and House space committees and appropriation subcommittees held extensive and detailed hearings on the proposed new U.S. space program. In the course of these, it became apparent that, with the lunar landing achieved, with America's concerns turning increasingly inward, and with competing budgetary demands by rapidly growing social programs, the current congressional mood was for diversified and practical space goals pursued at a moderate and economical pace. The new NASA program for the 1970's reflects these desires, while doing everything possible within an austere budget to maintain our forward momentum in space.

## II. CARE AND COMPETENCE REQUIRED TO SET BOLD REALISTIC GOALS

We believe that we have thoroughly done our homework in a thoughtful goal-setting process involving some of the best brains in the country. This is the responsible way to do it; as a nation, we must take a hard look at accepting national goals set by amateur enthusiasts no matter how well intentioned.

Austerity and progress can only be achieved through clear vision, sound planning and strong management. To strengthen the Space Agency's forward vision, I selected a man with an unmatched record of technical foresight to direct NASA's top-level long-range planning team: Dr. Wernher von Braun. Upon his arrival in Washington, we called together some of NASA's most experienced and creative scientists and engineers to help us explore man's future in space through the Year 2000. Starting from the recommendations of the President's Space Task Group, we asked each to predict in his areas of competence the future advances to be expected over the next thirty years assuming continuing public support at a level below 1% of the U.S. Gross National Product. Each forecast was discussed, analyzed, refined, and integrated with other likely technical developments in a four-day meeting at NASA's Wallops Island Station in Virginia. Today, I will summarize for you our resulting projections of potential space advances to the Year 2000.

III. CAVEAT

But first let me sound a clear warning. We are concerned only with what is technologically and economically possible by the Year 2000, not what will necessarily be accomplished. Barring a catastrophic war, the United States, the Soviet Union, Western Europe and Japan--alone, or in concert--will have the necessary industrial and economic resources to realize the advances I will describe. As will be pointed out, there will be substantial incentives to do so. But whether there will be the vision, leadership and will to do so is a question beyond the scope of this talk. The U.S. has sometimes failed to do desirable things which are technically and economically possible, like rebuild our decayed cities or run an efficient railroad system. On the other hand, the nation has made many wise long-range decisions too, from the G.I. Bill and interstate highway system to the Marshall Plan and civilian atomic energy program. For America, and for other countries, the response to the challenge and opportunity of space will determine their futures.

## IV. POST APOLLO PROGRAM

To realize the nation's broad objectives, a new space transportation system must become the key element of our program for the 1970's. It is the bridge to our future in space. The first component is the economical, fully reusable space shuttle capable of making many round trips to orbit with passengers and cargo. The second is the permanent space station in orbit where men and women from many nations can live and work for extended periods. We must then design and build automated and manned space tugs, vehicles whose whole life will be spent working in space, emplacing and recovering satellites and transporting personnel and equipment between orbits. With these three components in a space transportation system, we can capitalize upon the full promise of space in the 1980's and 1990's.

The Saturn V will complete the Apollo lunar landings by 1972 and then be terminated. The loss of its capability to put 130 tons into low earth orbit will be offset by a new approach to large payloads, based on the shuttle booster stage.

Three score and seven years ago, the Wright Brothers' crude biplane climbed a few feet above the dunes at Kitty Hawk and clattered through the air on its shaky first flight of 120 feet. Nobody foresaw then that within fifteen years flying aces would astonish the world with their aerial exploits in the skies over France, that less than a decade after that a young flier would pilot his fabric-covered "Spirit of Saint Louis" on a five-thousand-mile solo flight from New York to Paris, or that starting with the all-metal DC-3 hundreds of billions of dollars would be invested over the next forty years to create the global air transport system which now routinely flies twenty thousand passengers daily across the Atlantic.

Current progress in space flight is even outstripping aviation's fast-paced advance. Sputnik beeped its startling message of a new age in 1957. Four years later, Yuri Gagarin was photographing our planet from orbit, and eight years after that, Neil Armstrong, Buzz Aldrin and Mike Collins were televising man's first lunar exploration a quarter-of-a-million miles away from earth. Today, the space equivalent of the practical air transport is already under development: a reusable space shuttle rocket plane that will ferry men and equipment to and from orbit safely and inexpensively. This "DC-3 of Space" should enter routine service in this decade, drastically reducing the cost of space operations, providing convenient access to the space stations of the late 1970's.

Besides supporting the space station, the shuttle will be able to launch and service all unmanned spacecraft planned to be flown at the end of the decade. Thus, all of the launch vehicles of the 1960's--Saturns, Titans, Atlases and Deltas--will be retired. The small Scout may continue in service for some lightweight payloads or sub-orbital missions.

The space shuttle--in terms of importance, challenge and use of resources--will constitute NASA's major single effort during the next ten years. The future of both manned and unmanned programs depends upon it. Scientists and engineers are now at work designing shuttle systems and high-performance engines, supported by a sizable effort to advance technologies in critical areas, such as structures, materials, avionics, and power systems. Other nations have been invited to join in and contribute to the shuttle program. The final third of the decade will see the first use in earth orbit of the space tug, which will provide transportation service from the space station to satellites in other orbits. Preliminary studies of the design of the tug have begun in the United States and Western Europe. A later version will provide service from lunar orbit to lunar surface for economical and reliable transportation of men and equipment to and from the moon at the end of the decade.

Preliminary design work is underway on basic space station modules, and a broad technology program is advancing the state-of-the-art of such key components as recycling life support systems, data handling, artificial gravity, and experiment modules.

The space station final design will be based upon the knowledge of extended orbital flight provided by the Skylab Program. Scheduled to fly during 1973, Skylab will employ astronauts in space for up to two months to learn more about effective operations during long-duration space flight. The Skylab flights will be the nation's last manned space flight until the shuttle begins operation in the second half of the decade. Once shuttle flights become routine, space station modules will be ferried to orbit, joined together, and man's first permanent structures in space will begin to evolve. In the last third of the decade, space station size and capability will have grown to include large astronomical optical and radio telescopes, biomedical research facilities, high energy physics experiments, and many earth observation activities.

The last Apollos will fly to the moon by 1972, ending U.S. manned lunar missions for the remainder of the 1970's. Scientific and exploratory interest in the moon will continue, however, and analysis and evaluation of lunar materials and data already obtained will take years to complete. Based on the results of this work, planning will begin immediately for an integrated lunar exploration program to be undertaken in the early 1980's based on the space transportation system. The initial activity in that time period will be the establishment of a station in lunar polar orbit from which it will be possible to descend to any portion of the lunar surface for up to fourteen days. These systems will be under construction by the end of the decade, and will borrow heavily in their technology from the space station and tug in earth orbit. Extended stay-time and surface shelter and travel capabilities are not planned by the United States until the 1980's, although Soviet activities appear likely.

A broad, vigorous program to explore the planets is high on the U.S. space agenda for the 1970's. Two major accomplishments will highlight the decade:

- The unmanned Viking mission to land instruments on Mars in 1976--an auspicious event to open the third century of the country's history.
- The Grand Tour to the Outer Planets. In the late 1970's, the outer planets are uniquely positioned so that multiple planet fly-by missions are feasible with a single spacecraft. The next such opportunity is the Jupiter, Saturn, Pluto trip in 1977. This is followed by an opportunity to fly by Jupiter, Uranus and Neptune in 1979. We now plan to take advantage of both of these opportunities.

Other spacecraft will fly throughout the decade to the near planets, the outer planets and to the asteroids.

- Two Mariners will set sail in 1971 for the hundred-million-mile voyage to Mars, where they will settle into orbit and transmit back our first complete map of the red planet's surface.

- A third Mariner will depart earth in 1973, swing by mysterious Venus, and travel on to give us our first view of the surface of the planet Mercury.
- In 1972 and 1973, pioneers will be launched on our first trip to fly by mammoth Jupiter, the near-star planet.
- Helios, an advanced satellite developed by West Germany, will be launched in 1974 and 1975 on a trajectory to pass near and study the sun.

The planetary missions launched in the 1970's will be part of an orderly program that includes a visit to every planet in the solar system. The pioneering work of the 1970's using automated spacecraft will blaze a trail for eventual manned trips to Mars and Venus before the end of the century. Probes to the outer planets and other regions will continue to roll back the pages in the history of the solar system.

Beyond the solar system, automated and manned astronomical probes will look outward to extend our understanding of the universe through more intensive investigations in optical and radio astronomy and space physics. By the end of the decade, these investigations will be conducted by scientific researchers in space with their instruments as well as by automated flights where orbits different from that of the space station are required.

The space in orbit two hundred miles above the earth can be thought of as a vast new continent, equal in area to the surface of the entire globe. To reach this new world, you must travel 200 miles up and attain a velocity of 17,500 mph. You have then landed on the shores of this continent and can watch the earth turning silently below once every hour and a half. Travel is frictionless and effortless, flight paths are maintained with mathematical precision, no storms blow, there is no corrosion, noise, fog, or unforeseen barrier. The new continent was only discovered a dozen years ago, but cargoes are already being dispatched there at a rate of five per week.

This new region has already begun to assume economic importance and develop some foreign trade. It imports satellites from other continents below and exports in return weather observations, navigation instructions, communication relay services, mapping and geodetic data, defense information, and a wealth of scientific observations. As men build the first reliable and economical orbital transport--the space shuttle and space tug--and as they build the first permanent structures in orbit--skylabs and space bases--the difficulty and cost of working in this extremely valuable new region of the world will decrease dramatically. As a result, the new continent will become increasingly important as the leading world source of global information and communication services and then, inevitably, as a new home of men from earth.

For perhaps a million years, man has been acting out the human drama on a tiny blue planet teeming with life, against a cosmic backdrop of violently erupting matter and energy. Our earthly haven is surrounded by a restless universe of exploding and collapsing stars and star systems.

After centuries of patient observation and audacious feats of scientific reasoning, scientists are now making man aware of the tiny molecular building blocks of which he is composed, and of the enormous--perhaps limitless--universe in which he dwells. We find ourselves tantalizingly near the answer to the overwhelming questions of man's origin, his destiny, and of his uniqueness as the bearer of intelligence in the universe.

Before this century is out, we may have new answers to these questions. Our range and precision of observation is increasing rapidly, both outward into the vast cosmos, and inward into the intricate molecules of living organisms. We can now foresee a joining of these two great pathways of science--the disciplines of stellar-planetary evolution and of biological evolution. This is a primary objective of our future space program.

Is man unique in all the cosmos? Is there no other planet circling one of the hundred billion other stars in our galaxy, or a star in one of the ten billion other galaxies visible in our telescopes, where conditions also favored the spawning of our basic molecular structure? It seems incredible that we alone would have made the step to intelligent life; there must surely be vast numbers of other worlds with similar life forms based on molecular systems like ours, and even perhaps different life forms based on other complex molecular systems evolving in very different environments. Man may indeed be unique--but the odds against it approach a thousand billion billion to one.

## V. LIFE IN OTHER WORLDS

We are moving closer to an understanding of man's place in the violent universe as the tangled mysteries of molecular biology are being unravelled and as the laws governing the evolution of stars and planets are being established by astronomical observations from earth and from orbit. The direct search for extraterrestrial life is now being extended by spacecraft throughout the solar system, and by giant radio telescopes which have made several searches for distant broadcasts from intelligent life on planets circling stars far distant from our sun. Every experiment has so far been negative, but the search will continue.

In seeking life on other bodies in our solar system, we must look not only for forms similar to life on earth but for life forms totally foreign to our environment that might be capable of existing in the atmospheres or on the surfaces of Venus, Mars, Jupiter, Saturn, or their satellites. We do not know what may exist, but we are upon the verge of knowing.

If no life is found elsewhere in the solar system, that in itself will be an important discovery since it will establish limits on the conditions which must exist for the evolution of life elsewhere. These specific conditions can then be sought in other regions of the universe. With increasing understanding of planetary evolution, we should be able to pinpoint our future search for intelligence-carrying electromagnetic signals to the most promising planetary systems with which communication might be established.

Establishing the existence of extraterrestrial life would surely rank as one of the major discoveries in the history of science; even greater would be communication with other intelligent beings on distant worlds. Either of these events would inevitably and significantly alter the philosophical and religious beliefs of mankind. Our human culture would be profoundly affected by the realization that, as we journey through a universe whose infinity we can hardly comprehend, we are in company with other living beings evolving on their own distant worlds.

But if extraterrestrial life is not found in our solar system, we can only say that there is no life on our moon or the planets--yet. For man himself can be the bearer of life from the blue planet to other worlds across the void of space. A popular song in the Soviet Union goes: ". . . and apple trees will grow on Mars." Perhaps this is man's role in the evolution of our solar system. Our generation has taken the first step: we have carried life out to the moon.

Our vigorous national space program, now only twelve years old, has fared well under four Presidents of the United States, two of whom, utilizing broadly differing executive styles, were my bosses.

Starting behind Soviet competition in the late 1950's, the American space program finished the decade of the 1960's generally ahead. To achieve this required the invention of an entirely new independent executive agency of the government to organize in new ways the redoubtable capabilities of American industry, universities and science.

The stabilizing effect of Apollo on a World grimly locked in a potentially unstable cold war has not been underestimated by the thoughtful. History may record that the substitution of major international technical competition, in place of war, was the great and unprecedented peacekeeping breakthrough of our era. The beneficial stimulus created by this new type of peaceful competition on international social and technical change is evident to all.

President Kennedy's 1961 statement that his "decision to shift the national space effort into high gear would be among the most important decision he would ever make as President" was prophetic. It may become historic.

Our space agenda for the 1970's confronts the major nations and their leaders with the necessity to make equal, or perhaps even bolder decisions in space.